Pork Versus Public Goods: An Experimental Study of Public Good Provision Within a Legislative Bargaining Framework*

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Abstract

Once the legislature is faced with an exogenous budget constraint, public goods (both level and scope) have to be determined by some collective-choice procedure. We experimentally investigate a recent model in which legislators allocate a fixed budget between collective public goods and particularistic goods. Our results confirm

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that when legislators value of collective goods is relatively low, then the budget is almost exclusively allocated to particularistic goods within a minimum winning coalition. However, in the "mixed region" in which both collective goods and particularistic goods are provided, the share of the budget devoted to the public good decreases as the relative value of the public good decreases, which is inconsistent with the stationary subgame perfect equilibrium prediction of the bargaining game but can be rationalized given the subjects voting behavior.

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JEL classification: C7, D72, C92, C52.

1 Introduction

One of the most important questions in economics and political science is understanding how any collective body makes decisions, and, in particular, under what conditions we can expect an efficient provision of public goods by such collective bodies. Public good provision is a key aspect of what governments and legislatures do, and governments and legislatures are the most important suppliers of public goods. Even in countries where the government is not the most important supplier of public goods like health care and education, it is often the sole supplier of some key public goods such as defense and law enforcement. However, collective decision making bodies are far from being "benevolent unitary actors." Rather their members are constantly trading off the virtues of the public goods under consideration against the attractiveness of spending the money on particularistic goods (pork) benefiting themselves individually or their districts.[1] Theoretical and experimental methods can help clarify this trade-off, with our goal in this paper being to identify and characterize the *behavioral patterns* of a collective body facing these types of choices.

All of the experimental literature on public good provision has focussed on voluntary contribution mechanisms in which individual agents decide between allocating their personal endowment between their own private use or benefits for the group as a whole. But voluntary contribution mechanisms have a very different structure from those legislators face in bargaining over budget allocations, as public goods (both level and scope) have to be determined by some collective-choice procedure, and there always are particularistic goods available as alternative ways to use the budget. Thus, we need to turn to a reasonably appropriate model that explicitly considers the political process by which public goods are provided to capture the competing forces at work in political institutions.

For the most part, legislative bargaining theory has focused either on distributive politics or on policy decisions. Only recently have there been major efforts to model legislators' incentives to provide public goods when the alternative use of the budget is to provide particularistic goods.[2]. Volden and Wiseman (2005) provide a benchmark model for our

[1] Particularistic goods here can be local public goods in the sense that they primarily yield benefits within the district of the legislator in question. In this sense public goods refer to more global public goods which are enjoyed by all districts.

[2] There is a line of research incorporating collective and particularistic elements (e. g., Austen-Smith and Banks 1988, Crombez 1996, Banks and Duggan 2000, Baron and Diermeier 2001, Jackson and Moselle 2002, Morelli 1999, Goertz 2006), but those models do not capture the explicit trade-offs resulting from the fact

experimental analysis, since they model a bargaining game where legislators can agree on any division of the budget between particularistic and collective good spending.[3]

Previous experimental work on legislative bargaining has focused on purely distributive settings. The motivation behind these experiments has been to investigate the ability of the stationary subgame perfect equilibrium outcome to characterize allocations compared to alternative models used to characterize these settings, to measure the bargaining power of the agenda setter, and to determine whether or not Riker's minimum-winning-coalition view of coalition formation is confirmed (see E.G. Fréchette, Kagel and Morelli, 2005a – FKMa henceforth – and the references cited therein) Adding the possibility of proposing different combinations of private and public goods introduces a number of interesting new behavioral questions: Given that public good offers are by definition to everyone, will agents be biased (relative to the theory) in favor of the public good provision out of equity, efficiency or some other considerations? Can the possibility of public goods increase proposer power in some situations? What happens to the proposed combinations of private and public goods when the relative value legislators place on public goods (their greed for private goods) changes? With respect to this last question, there are competing forces pushing in different directions: when the relative value of the public good decreases there is a reduction in the total value of the shares to be allocated as well as a change in the *marginal rate of substitution* between private and public goods, with these income and substitution effects pushing in different directions in terms of the incentives proposers face for deciding between public and private goods.

The Volden and Wiseman (2005) model extends the Baron-Ferejohn (1989) alternating-offer model of majoritarian bargaining to a legislature determining how to allocate a fixed budget between public goods that benefit all legislators' districts and particularistic goods that benefit an individual district. In its closed-rule, infinite-horizon form, someone is picked at random to make a proposal, then the others simultaneously vote yes or no on it. If the majority rejects the proposal then a new proposer is chosen at random, with the process

that private and public good spending are alternative uses of *the same* fixed budget.

[3]Lizzeri and Persico (2001) capture some of the trade-offs between public and private goods in party platforms. Leblanc, Snyder and Tripathi (2000) and Battaglini and Coate (2006) also contain interesting predictions about legislative bargaining on multi-policy decision making. We focus on the Volden and Wiseman paper because it explicitly deals with the comparative statics we are interested in, namely the changes in bargaining behavior as legislators' utility from pork relative to common interest policies varies.

repeating until an allocation is determined (with discounting on the size of the budget).[4] Legislators utility functions attach value to the public and private goods, with weights being the same across all legislators. This utility function and the weight associated with the value of public versus particularistic goods can be thought of as a reduced form expression incorporating the impact of the electoral system. That is, in systems where a politician's survival is determined more by what happens locally, then the weight put on public goods will be small.

In our experiment we vary these weights across treatment conditions in order to produce (1) a situation in which there is a unique equilibrium in which only public goods are provided (a dominant strategy for all players), (2) a mixed region in which both public and private goods are provided and (3) a region with a unique equilibrium with only private goods provided (within a minimum winning coalition). The model predicts, somewhat counterintuitively, that for intermediate values of the weight of the public good in legislators' utility functions (henceforth the mixed region), the level of public goods provided *increases* when legislators care more about particularistic goods. This is because the proposer, in using the standard subgame perfect equilibrium logic, needs to offer a public good amount *on* the "participation constraint" of responders, and the latter would be violated if the proposer didn't increase the public good level when its value goes down.

This comparative static prediction within the mixed region is quite important for comparative politics and for our understanding of economic policy making in different systems: it is well known that when legislators are elected with Single Member District plurality or majority rule, they should care more about their performance for their district compared to legislators elected with national lists, like in many European countries. This prediction of the model in the mixed region, that the level of public goods will increase as legislators place greater weight on particularistic goods, suggests, in contrast with our intuition, that under some circumstances, single member district systems will induce legislators to produce *more* public goods than Proportional Representation systems. Empirical research with field data supports the fact that single member districts produce *less* public goods (more pork) compared to proportional representation systems (see e.g. Persson and Tabellini 2006). But these results are clouded by the fact that the data for single member districts is dominated

[4] The discounting is designed to capture delay costs, including the fact that legislators may not be reelected to enjoy the fruits of their labor.

by the United States, which has a host of potentially confounding, idiosyncratic, factors associated with it. Our experimental investigation of the comparative static predictions of the Volden-Wiseman (2005) model within the mixed region provides another way of looking at this issue, one that is free from these (potential) confounding factors.

Our main experimental results can be summarized as follows: First, the level of public goods provided varies monotonically with the relative value of private versus public goods in the utility function, not only across regions but also within the mixed region. Within the pure private goods region, the predominant tendency is for minimum winning coalitions with no public goods. Within the mixed region two types of allocations predominate, ones with *only* public goods, or ones with both public and private goods, with the latter allocated exclusively to the proposer (i.e., equilibrium type allocations).[5] Thus, the overall allocation of public goods within the mixed region is substantially higher than the theory predicts, both because of the all public good allocations and the fact that the amount of money proposers take for themselves is substantially smaller than predicted. Further, this holds whether we condition on equilibrium type allocations within the mixed region (i.e., ignoring the all public good offers) or not, so that behavior is inconsistent with the comparative static prediction of the stationary subgame perfect equilibrium prediction within the mixed region.

Our experiment also has implications for the public goods literature as it provides an entirely different framework for (and underlying game theoretic model of) public goods provision compared to voluntary contribution and provision point mechanisms that are typically investigated. Our results are similar in some dimensions to VCM and provision point experiments; e. g., the level of public good provision is higher than predicted for parameter values where VW model predicts a mixture of public and private goods. However, for parameter values where the theory predicts only private goods, there are virtually no public goods provided nor much of an attempt to provide those goods at any point in an experimental session. The experiment also has implications for the "other regarding preference literature" that has grown up around bilateral bargaining games in the economics literature (i.e., concern for others' income that goes beyond the usual assumption that only

[5] Throughout the paper we will use the terminology "equilibrium type" proposal or offer to mean a proposal that allocated strictly positive amounts of particularistic goods to the right number of subjects although not necessarily in the right quantity.

own income matters). These implications are discussed in the concluding section of the paper.

The plan of the paper is as follows: Section 2 outlines the Volden-Wiseman (2005) model that serves as our benchmark. Sections 3 and 4 give the experimental design and the results, respectively. Summary and concluding remarks are reported in Section 5.

2 Benchmark Model and Related Hypotheses

In this section we describe the model of Volden and Wiseman (2005).

Consider a legislature of N politicians, representing different legislative districts, who have to make a collective decision on how to allocate a fixed budget between a public good and private goods (pork barrel projects). Let N be an odd number. Denoting by y the share of the budget allocated to the public good and by x the N-dimensional vector of private good shares allocated to the N legislators ($y + \sum_{i=1}^{N} x_i \leq 1$), the utility function of each legislator is given by

$$U_i(x, y) = \alpha x_i + (1 - \alpha) y q$$

where $\alpha \in [0, 1]$ is the relative weight of private goods in the utility function[6] and q represents the absolute value (or return) of spending a dollar in public good production.[7] Each legislator has the same probability of being selected by Nature as the proposer of a division of the (unitary) budget. If at least $(N - 1)/2$ responders accept the proposal the budget is divided according to the proposal. If the majority rejects, another random proposer is selected, and the budget shrinks using the discount factor δ. The status quo is no division of the budget. The bargaining game is therefore a straightforward extension of the (closed rule) infinite horizon bargaining game of Baron and Ferejohn (1989) to a budget division involving two dimensions - public and particularistic goods. The solution concept is stationary subgame perfection.

[6] Volden and Wiseman (2007) develop a slightly different model where α is not constrained to take on values between 0 and 1, and legislators' utilities are defined as $\alpha x_i + qy$. This specification does not qualitatively effect the equilibria, nor does it affect the comparative statics predictions that we experimentally examine in this paper. We prefer to test the model in its (2005) formulation because we want to vary the "relative" value of private and public goods (by varying α across treatments) without scaling utility up and down in absolute terms.

[7] The weight placed on private goods, α, can vary across legislators, which introduces a number of interesting possibilities that lie beyond the scope of the present paper.

The model predicts that, fixing q, for low values of α only the public good will be supplied, as it is a dominant strategy to do so. At the other extreme, for high values of α only the private goods will be offered, in which case only a minimum winning coalition (MWC) receives positive shares. For intermediate values of α the public good is supplied and the proposer takes some private benefits for himself, but does not offer private benefits to anyone else. The lower bound on the mixed region is given by

$$\alpha_{CM} = \frac{q}{1+q}.$$

The upper bound on the mixed region is given by

$$\alpha_{MP} = \frac{q(N+1)}{2+q(N+1)}.$$

If $\alpha \leq q/(1+q)$ (or $\alpha \leq q$ in their 2007 version), a proposer has absolutely no incentive to offer a mixed offer or particularistic coalition: doing so would mean procuring particularistic goods that carry a lower marginal utility than the public good. If $\alpha \in (\alpha_{CM}, \alpha_{MP}]$, a proposer also will have no incentive to deviate and offer a collective proposal. Doing so would surely be approved by all legislators since $1 > y_M$. However, the individual rationality constraints checked on page 90 of the paper apply here and already show that a proposer would prefer the mixed outcome to this collective outcome.

For the second cut-point, one needs to show that if $\alpha > \alpha_{MP}$ the proposer does not have an incentive to deviate and make a mixed offer, and if $\alpha \in (q/(1+q), \alpha_{MP}]$, the proposer does not have an incentive to form a particularistic coalition.[8]

In the mixed region, as α increases, the proposer *decreases* the share of the budget he takes for himself in terms of private benefits. In other words, the theory predicts a *non monotonic* relationship between the supply of the public good and the value legislators place on private goods (α). Thus, starting with low values for the private good (low values

[8] These incentives to deviate are correctly taken into account in the errata corrige of Volden and Wiseman (cite), whereas they had not been taken correctly into account in the published version. As one can verify from the errata cited above, the new cut-point for their formulation is

$$\alpha'_{MP} = \frac{q(n+1)}{2}.$$

To go from this cut-point in their paper to the cut-point for our case where $U^i = \alpha x^i + (1-\alpha)qy$, define $(1-\alpha)q = q'$. Then

$$\alpha'_{MP} = \frac{q'(n+1)}{2} = \frac{(1-\alpha)q(n+1)}{2}.$$

Solving for α_{MP}, we obtain the cut-point in the text.

of α) the private good share for the proposer is first zero, then once α reaches α_{CM} it jumps up and then decreases within the mixed region, only to jump up again when the value of α becomes so high that no public good is offered anymore. Finally, when α is so high that only private goods are offered, the share going to the proposer as α varies is predicted to remain constant.

The intuition behind the comparative static result just described for the mixed region is as follows: when α goes up the payoff for the responders goes down if the offer is the same as the one before α changed; hence, the proposer increases y in order to partially compensate for this, as this is needed for the proposal to be accepted. The offer of any proposer in equilibrium is always predicted to be "just enough" to get the responders to accept it. Thus the comparative static result just described is determined by the effect of a change in α on the responders' "participation constraint".[9]

3 Experimental Design

Each experimental session used a legislature/committee comprised of $N = 5$ subjects, with the value of the public good always $q = 0.7$, and the discount factor $\delta = 0.8$. Thus the range for the mixed region is given by $[\alpha_{CM}, \alpha_{MP}) = [0.412, 0.677)$. The different values of α used in experimental treatments were 0.3, 0.45, 0.55, and 0.75. N and δ correspond to values used in previous studies of the BF game.

Subjects were told that they had to decide how to divide 50 "francs" between "... two types of allocations: (i) allocations to individual voters or (ii) allocations to the group of voters as a whole (called the group allocation)." They were told the payoff in francs allocated to the group as a whole as well as the payoff in dollars was a function of "...francs allocated to you as an individual as well as your share of the group allocation." Everything was computerized with subjects screens automatically calculating the conversion rate from the group allocation to individual payoffs, as well as the dollar payoffs for any proposed allocation (see http://homepages.nyu.edu/~gf35/print/fkm_pg_online_appendix.pdf for sample instructions and screen shots).

Table 1 gives the equilibrium predictions for each value of α used in the experiment.

[9] The theoretical prediction that the equilibrium public good offer y is decreasing in q comes from the same effect on the acceptance threshold.

α	Budget Share		Payoffs		Efficiency
	Public Good	Private Allocation	Proposer	Responders	
0.3	1	0	\$24.50	\$24.50[a]	1.000
0.45	0.483	0.517	\$20.95	\$9.30[a]	0.60
0.55	0.583	0.417	\$20.65	\$9.20[a]	0.73
0.75	0	0.68	\$25.50	\$6.00[b]	0.86

α = weight placed on private goods in members utility function.

[a] Given to all responders.

[b] Given to coalition partners within a minimum winning coalition.

Table 1: Theoretical Predictions

The share of francs devoted to the public good is reported along with the share going to the proposer. Dollar payoffs convert these shares into players' payoffs with the last two columns representing shares to responders. Note that except for the case of pure private goods ($\alpha = .75$), shares to responders represent only payoffs from the public good. In the pure private goods case, shares are allocated only to members of the minimum winning coalition (MWC). Table 1 also shows the efficiency levels predicted under the SSPE. In all cases efficiency is maximized when $y = 1$ as this provides maximum total money payoffs. Efficiency is measured as the ratio of the difference in the sum of the utilities (monetary payoffs) in equilibrium and the sum of the utilities when $y = 1$.

Between 10 and 20 subjects were recruited for each experimental session, so that there would be a minimum of 2 bargaining rounds conducted simultaneously in each session and a maximum of 4.[10] After each bargaining round, subjects were randomly re-matched. Subject numbers also changed randomly between bargaining rounds (but not between the stages within a given bargaining round).

Procedures for each bargaining round were as follows: First all subjects entered a proposal on how to allocate the 50 francs. Then one proposal was picked randomly to be the standing proposal. This proposal was posted on subjects' screens giving the amounts in francs allocated to each subject along with the dollar shares implied by the given allocation

[10] Our intention was to have a minimum of 15 subjects in each session, but in some cases enough extras showed up to be able to run four bargaining groups. Two sessions fell short of the desired 15 subjects and were conducted with 10 subjects each (see Table 2 below). There are no discernible differences between sessions as a consequence of the number of subjects present.

			Final Payment in $		
Treatments (value of α)	Session	Number of Subjects	Min	Max	Average
0.3	1	10	27.60	30.40	29.30
	2	15	32.50	32.50	32.50
0.45	3	15	25.40	27.60	26.61
0.55	4	15	19.10	26.10	21.48
0.75	5	20	8.90	20.20	15.73
	6	20	8.40	22.30	15.56
0.45 to 0.55	7	10	39.30	45.40	42
0.55 to 0.45	8	15	37.40	44.20	40.81

Table 2: Experimental Sessions

as determined by the utility function $U_i(x, y)$ along with the value of α in effect for that treatment.[11] Proposals were voted up or down, with no opportunity for amendment. If a simple majority accepted the proposal the payoff was implemented and the bargaining round ended. If the proposal was rejected, the process repeated itself (hence initiating a new stage of the same bargaining round). Complete voting results were posted on subjects' screens, giving the dollar amount allocated by subject number along with the francs allocated to the public good, whether that subject voted for or against the proposal, and whether the proposal passed or not.[12]

A total of 8 sessions, all with inexperienced subjects, were conducted. Table 2 lists the values of α along with the number of subjects in each session. Sessions 1-6 all employed 12 bargaining rounds, with one of the rounds, selected at random, to be paid off on.[13] Sessions 7 and 8 employed a cross-over design with an initial set of 12 bargaining rounds with values of α equal to .45 and .55, respectively. These were followed by another 8 bargaining rounds in which the value of α was changed from .45 to .55 in session 7 and from .55 to .45 in

[11] For example, in the $\alpha = .55$ treatment with 40 francs allocated to the public good, with the remaining 10 francs allocated to the proposer, subjects would see the implied dollar allocations ($12.60 for responders, $18.10 for the proposer) on their screens for all players along with the allocations in francs.

[12] Screens also displayed the proposed shares and votes for the last three bargaining rounds as well as the proposed shares and votes for up to the past three stages of the current bargaining round. Other general information such as the number of votes required for a proposal to be accepted were also displayed.

[13] These cash bargaining rounds were preceded by a bargaining round in which subjects were "walked through" the various contingencies resulting from, for example, accepting or rejecting offers.

session 8. These cross-over sessions were conducted as the between session results with $\alpha = .45$ and .55 failed to show the predicted increase in the share of francs allocated to the public good. This design was employed to enable us to use own subject control to test this sensitive comparative static prediction of the model, and to provide subjects with the most striking contrast in terms of their own payoffs for the failure to increase (decrease) the public good allocation following the increase (decrease) in α that the theory predicts. In both of these sessions, subjects were paid on the basis of one random draw from each of the two sets of bargaining rounds. However, these draws were only made *after* both sets of bargaining rounds had been completed, while the planned change in the value of α, along with the extra 8 bargaining rounds, was only announced at the end of the first set of 12 bargaining rounds.[14]

Subjects were recruited through e-mail solicitations from students enrolled in economics classes at The Ohio State University. This resulted in recruiting a broad cross-section of undergraduates and an occasional graduate student. All subjects received a participation fee of $8 along with whatever monetary allocation they obtained from the randomly selected bargaining round(s). Sessions lasted between an hour and fifteen minutes and an hour and forty five minutes. Table 2 gives the minimum, maximum, and average earnings including the show-up fee for each session.

The rest of the paper will be organized as follows. First, the performance of the SSPE prediction of the model will be evaluated in several dimensions: the length of bargaining rounds, the number of subjects being allocated particularistic goods by treatment, the impact of α on the quantity of public goods, proposal power, and efficiency. The results will be organized by first presenting evidence followed by a summary of the evidence reported in the form of a "Conclusion." Second, the main deviation from the theory identified in the mixed public and private good region will be explored further. The third part is a discussion relating these results to results from other experiments.

[14] That is, instructions for the first 12 bargaining rounds were in all respects the same as the instructions for the corresponding sessions without the change in the value of α.

4 Results

4.1 Testing the Theory

Most bargaining rounds had only 1 stage. More specifically, 89% of bargaining rounds ended in stage 1, 10% in stage 2, and 1% in stage 3. The number of rounds ending in stage 1 increased to 92% for the rounds 10 and above.[15]

Conclusion 1 *The vast majority of bargaining rounds ends in stage 1 as the theory predicts, with only 1% of all bargaining rounds extending beyond stage 2.*

The number of subjects included in proposals is reported in Table 3. For 3 of the 4 values of α the modal offer yields private benefits to as many subjects as the equilibrium predicts. The exception is for $\alpha = .45$ where the modal proposal involves all public goods instead of the mixed allocation the theory predicts. With $\alpha = .55$, there is also a large cluster of all public good offers: 35% of all such proposals versus 40% where the proposer takes something extra for himself with all public goods to others (equilibrium type offers). Thus, in both cases there are too many allocations of the more efficient, all public goods, option. However, when private benefits were provided in addition to the public good, the frequency with which the proposer only allocated benefits to himself clearly dominates. Further, experience tends to move behavior closer to the predicted outcome for all values of α as there are more equilibrium type proposals after round 9 for all treatments: 36% after versus 30% before round 9 for $\alpha = .45$ and 52% after versus 40% before round 9 with $\alpha = .55$.[16]

The $\alpha = 0.3$ condition reveals some inefficiencies in choices as 26% of all proposals involve some private goods. In this treatment, not only is this not equilibrium behavior, it is dominated by all public good allocations. However, these misallocations are relatively small in magnitude as the average share of francs allocated to the public good in this treatment was 91.4% calculated over all rounds, and 95.3% for rounds 10 and above (see

[15] Given that most of the data is in stage 1, the data analysis that follows uses stage 1 data only, unless noted otherwise. This is done for convenience, as it makes comparisons simpler since we do not have to worry about the effect of discounting on payoffs.

[16] For the cross-over sessions we include data for all 8 bargaining rounds after the change in α when characterizing experienced play (periods 10 and above). We do so on the grounds that subjects are already quite familiar with the structure of the game. Results for experienced play are robust to limiting the data to the last 3 bargaining periods before and after the crossover.

	Number of Subjects Offered Private Allocations					
	0	1	2	3	4	5
$\alpha = 0.3$	**0.74**	0.01	0.00	0.07	0.03	0.15
$\alpha = 0.45$	0.55	**0.30**	0.01	0.04	0.01	0.09
$\alpha = 0.55$	0.35	**0.40**	0.01	0.10	0.04	0.11
$\alpha = 0.75$	0.03	0.00	0.00	**0.65**	0.05	0.26
Rounds 10 and Above						
$\alpha = 0.3$	**0.75**	0.03	0.00	0.08	0.03	0.12
$\alpha = 0.45$	0.56	**0.36**	0.01	0.02	0.00	0.05
$\alpha = 0.55$	0.35	**0.52**	0.01	0.06	0.02	0.05
$\alpha = 0.75$	0.06	0.01	0.00	**0.74**	0.02	0.17

Equilibrium Type Offers are in Bold.

Table 3: Frequencies With Which Different Numbers of Subjects Were Allocated Private Benefits

below). By the end, in round 12, these allocations of particularistic good represented 2% of the money available**.** The appendix contains a table for the number of subjects offered private allocations for *accepted* offers. The relative frequencies are very similar to those shown in Table 3.

Conclusion 2 *The modal offer yields private benefits to as many subjects as the theory predicts for 3 out of 4 values of* α*. The exception is for* $\alpha = 0.45$ *where the modal offer involves all public goods. There is a much higher frequency of all public good offers than the theory predicts in the mixed public and private goods region. But when private benefits are offered in this region, they typically go only to the proposer as the theory predicts.*

Table 4 gives the average proposed share of francs allocated to the public good by treatment for all proposals and for equilibrium type proposals.[17] For all proposals, averaging over all bargaining rounds, almost the same allocations are made to the public good with $\alpha = 0.3$ as with $\alpha = 0.45$. Further, although average public good shares are larger with $\alpha = 0.3$ for later bargaining rounds (10 and above), the difference is not statistically significant using a rank sum test with subject averages as the unit of observation (p-value > 0.1). All of the

[17] Average accepted shares are quite similar to proposed shares.

	All Proposals		Equilibrium Type Proposals	
	All Rounds	Rounds > 9	All Rounds	Rounds > 9
$\alpha = 0.3$	0.914	0.953	1.000	1.000
$\alpha = 0.45$	0.914	0.937	0.864	0.875
$\alpha = 0.55$	0.829	0.866	0.842	0.844
$\alpha = 0.75$	0.104	0.078	0.039	0.017

Table 4: Average Proposed Provision of Public Good

other differences in average public good shares are statistically significant (p-value < 0.01). In particular there is a statistically significant *decrease* in the allocation to public goods with $\alpha = 0.55$ versus $\alpha = 0.45$, contrary to what the theory predicts.[18] This difference, although relatively small is quite robust. For example suppose that we drop all the subjects who always propose only public goods with $\alpha = 0.45$ on the grounds that they are simply miscalibrated, which biases the average allocation against what the theory predicts.[19] Then looking at the cross-over sessions, the average share of the budget allocated to the public good for all proposals for all rounds is 0.88 with $\alpha = 0.45$ versus 0.78 with $\alpha = 0.55$, and 0.89 versus 0.83 in rounds 10 and above, with both these differences statistically significant at the 5% level using subject averages as the unit of observation. Also note the small share allocated to the public good with $\alpha = .75$, very close to the misallocation (but in the opposite direction) to $\alpha = .3$. This represents a rather dramatic drop-off in the share allocated to the public compared to the other parameter values.

The average proposed share of francs allocated to the public good conditional on the proposals being of equilibrium type naturally decreases between $\alpha = 0.3$ and $\alpha = 0.45$. What is more interesting is the observation that the average share of resources allocated to the public good also decreases going from $\alpha = 0.45$ to $\alpha = 0.55$ as this contradicts the key non-intuitive comparative static prediction of the model.

[18] This is established two ways, both using subject averages as the unit of observation. One way is using the ranksum test for all rounds except those after round 12. The other is using the Wilcoxon matched-pairs signed-ranks test using data from the cross-over sessions. In both cases we can reject a null hypothesis of no difference in favor of a smaller allocation with $\alpha = 0.55$ at the 0.01 level or better.

[19] This accounts for 9 out of 25 subjects for all rounds and 11 out of 25 subjects for rounds 10 or higher in the cross-over sessions.

The flip side of this, is that if we look at the share of the private good that proposers allocate to themselves, conditional on equilibrium type allocations (public goods with only private goods to themselves), the average private share for accepted offers goes from 0.101 with $\alpha = .45$ to 0.135 for $\alpha = .55$ (p-value < 0.05 for the ranksum test excluding observations after the cross-over and p-value < 0.1 for the Wilcoxon matched-pairs signed-ranks test using data from the cross-over treatments).[20] This doesn't go away over time either: looking at bargaining rounds 10 and higher, shares are .11 and 0.15, so that the difference is even greater, and still in the wrong direction relative to what the theory predicts (p-value < 0.05 for the ranksum test excluding observations after the cross-over.[21]

Conclusion 3 *Public good provision is flat between the region where the theory predicts all public goods and the start of the mixed region, then decreases monotonically between regions after that. Notably, public good provision decreases* ***within*** *the mixed public and private region contrary to the model's prediction.*

Table 5 gives the theoretical prediction (SSPE) in terms of public good allocation and particularistic allocation to the proposer for each treatment as well as the payoffs to the proposer and responder. It also reports the average for all accepted offers, and the average conditional on the offer being accepted and being of equilibrium "type". Notice that in the case of $\alpha = 0.75$, for the equilibrium prediction and for equilibrium type offers, since these are MWCs, the responders average payoff must be multiplied by 2 to know how much the responders within the MWC are being offered. Hence, the average payoff difference between proposers and responders is \$0.07, \$0.86, \$1.86, and \$8.05 for the α equal to 0.3, 0.45, 0.55, and 0.75 treatments respectively. Conditioning on the offer being an equilibrium type offer, the differences are \$0.00, \$2.27, and \$3.67 for the α equal to 0.3, 0.45, and 0.55 treatments, and \$4.58 *within* the MWC for $\alpha = 0.75$. Other than for $\alpha = 0.3$, these differences are all statistically significant ($p < 0.01$ ranksum test on subject averages). Thus, proposer power grows monotonically as α increases. As a fraction of predicted proposer advantage, these differences represent 19%**,** 32%**,** and 23% for the α equal to 0.45, 0.55, and 0.75 treatments, respectively, so that as a percentage of the predicted share proposer power is relatively stable

[20] When using the ranksum test, observations after the cross-over are excluded since the data is averaged by subject, so that the before and after cross-over data are probably not independent for a given subject.

[21] There aren't enough observations in this case to establish statistical significance with the Wilcoxon matched-pairs signed-ranks test using data from the cross-over treatments.

α		Budget Share		Payoffs	
		Public Good	Particularistic Allocation	Proposer	Responders*
0.3	SSPE	1	0	\$24.50	\$24.50
	Average All	0.967	0.010	\$23.84	\$23.77
	Avg. Eq. Type	1	0	\$24.50	\$24.50
0.45	SSPE	0.483	0.517	\$20.95	\$9.30
	Average All	0.931	0.044	\$18.92	\$18.06
	Avg. Eq. Type	0.899	0.101	\$19.58	\$17.31
0.55	SSPE	0.583	0.417	\$20.65	\$9.20
	Average All	0.896	0.075	\$16.17	\$14.31
	Avg. Eq. Type	0.857	0.135	\$17.22	\$13.55
0.75	SSPE	0	0.68	\$25.50	\$3.00
	Average All	0.102	0.351	\$14.07	\$6.02
	Avg. Eq. Type	0.041	0.408	\$15.64	\$5.53

SSPE = predicted under the stationary subgame perfect equilibrium.

Average All = averages for all accepted offers.

Avg. Eq. Type = averages for equilibrium type offers.

* Average over all 4 responders even when less than 4 subjects are allocated strictly positive amounts.

Table 5: Theoretical Predictions and Observed Averages for Accepted Offers

and well below predicted levels.

Conclusion 4 *Proposers exploit their power by taking greater shares than what they offer others in every treatment where they are predicted to do so. However, the amount of proposer power is significantly less than what is predicted under the SSPE.*

To summarize, the theory performs well in many dimensions. First, subjects almost always agree on a division in round 1 as predicted. Second, there is some proposer power in both the mixed region and in the all private goods region. In addition, for most treatments, the modal proposal gives particularistic goods to the predicted number of subjects. There are however three main deviations from the theory. First, the extent to which proposer power is exercised is far from what is predicted in the SSPE. Second, in the $\alpha = 0.45$ treatment the modal offer is an all public goods offer. Third, the fraction of resources allocated to public goods decreases with as α increases. These last two deviations are explored next, and the first one is discussed when these results are related to previous experiments.

4.2 Deviations in the Mixed Region

As documented in Tables 5, 4, and 3, there is a higher than predicted provision of the public good when $\alpha = 0.45$ but contrary to the comparative static prediction of the model, public good provision decreases in going from $\alpha = .45$ to $\alpha = .55$. At the heart of these deviations from the theory are differences between the continuation value as given by the SSPE (CV) versus how subjects vote and the proposals they can expect to see conditional on rejecting an offer (or the empirical continuation value, ECV). In what follows we document this fact.

Figure 1 shows, for each treatment, the amounts offered to potential coalition partners and whether or not these shares were voted up or down (excluding the shares and votes of proposers). Also listed in the figure are lines to indicate how subjects would vote if they used the continuation value as given by the SSPE (CV) or how they would vote based on the discounted average payoffs in the data (the empirical continuation value, ECV).[22] When $\alpha = 0.3$ or $\alpha = 0.75$, CV and ECV are almost the same and thus the distinction does not add much. However, when $\alpha = 0.45$ and $\alpha = 0.55$, ECV is closer to the point where offers

[22] The values (going from $\alpha = 0.3, 0.45, 0.55$, and 0.75 respectively) are \$19.60, \$7.44, \$7.36, and \$4.80 for CV; \$18.67, \$14.41, \$11.15, and \$5.08 for ECV.

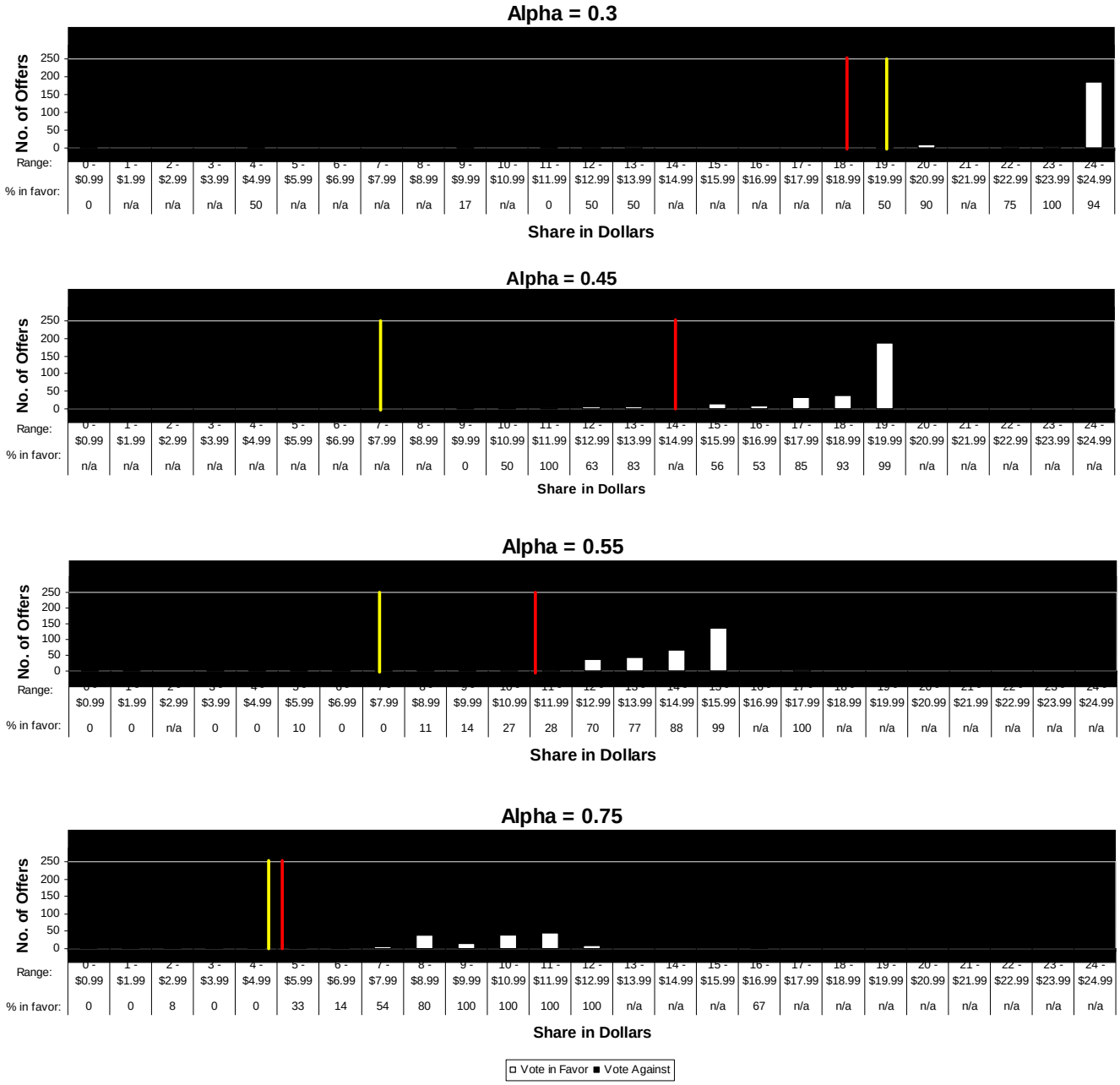

Figure 1: Voting Behavior

	Pooled Data
Payoff	17.30***
	(1.05)
CV	-2.09
	(1.49)
ECV	-11.70***
	(1.81)
Constant	-0.83***
	(0.04)
ρ	$0.30^{\S\S\S}$
	(0.07)
Observations	1312
Number of subjects	120

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

§ significant at 10%; §§ significant at 5%; §§§ significant at 1% using a likelihood ratio test

Table 6: Random Effects probit Estimates of the Determinants of Vote

	$\alpha = 0.3$	$\alpha = 0.45$	$\alpha = 0.55$	$\alpha = 0.75$
Own Payoff	12.98**	36.11***	39.29***	21.66***
	(5.38)	(6.50)	(4.90)	(2.11)
Payoff to the Proposer	-5.06	-20.81***	-11.65***	0.21
	(5.63)	(6.29)	(2.79)	(1.20)
Constant	-2.09***	-2.62	-5.53***	-2.97***
	(0.63)	(1.76)	(0.86)	(0.52)
ρ	$0.23^{\S\S}$	$0.61^{\S\S\S}$	$0.54^{\S\S\S}$	0.02
	(0.13)	(0.13)	(0.11)	(0.02)
Observations	240	336	400	336
Number of subjects	25	40	45	35

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

§ significant at 10%; §§ significant at 5%; §§§ significant at 1% using a likelihood ratio test

Table 7: Random Effects probit Estimates of the Determinants of Vote

start to be accepted than CV is. Further, most of the offers in the mixed region are to the right of the ECV, with few offers below CV or inbetween the CV and ECV lines.

To confirm that the ECV correlates better with the decision to accept or reject an offer than CV we do the following. The data, pooled across treatments and votes (excluding the proposer's), are regressed on CV and ECV (using a probit with random-effects at the subject level). A vote in favor is set to 1 and a vote against is 0. The theory being fully correct would require CV to be statistically significant. As can be seen in Table 6 CV is not statistically significant, but ECV is.[23]

This leaves open the question of what factors underlie how subjects vote on proposals. Table 7 explores this where we regress votes as a function of own payoffs as well as payoffs to the proposer. As shown, own payoff is significant in every treatment. However, for the mixed region the payoff to the proposer has a negative impact on the likelihood that a

[23] The Table also reports estimates of $\rho \equiv \frac{\sigma_\alpha^2}{\sigma_\alpha^2+1}$, where σ_α^2 is the variance of the subject specific random effects. ρ measures the extent of the individual subject effects, or the dispersion in the likelihood of acceptance across individual subjects. ρ has a minimum value of 0 (no individual subject effects) and a maximum value of 1 (all the variance is explained by individual subject effects).

	$y=1$				EV Optimal				SSPE			
	y	x_{prop}	EV	Prob.	y	x_{prop}	EV	Prob.	y	x_{prop}	EV	Prob.
$\alpha = 0.3$	1.00	0.00	\$18.91	1.00	1.00	0.00	\$18.91	1.00	1.00	0.00	\$18.91	1.00
$\alpha = 0.45$	1.00	0.00	\$19.25	1.00	0.89	0.11	\$19.53	0.99	0.48	0.52	\$14.41	0.00
$\alpha = 0.55$	1.00	0.00	\$15.75	1.00	0.86	0.14	\$17.12	0.95	0.58	0.42	\$11.17	0.00
$\alpha = 0.75$	1.00	0.00	\$7.44	0.80	0.00	0.47	\$15.67	0.91	0.00	0.68	\$8.45	0.41

EV: Expected Value

SSPE: Stationary Subgame Perfect Equilibrium

x_{prop}: Particularistic allocation to the Proposer

Prob. Probability of such a proposal being passed.

Table 8: Expected Payoffs

proposed offer will be accepted, which limits the ability of proposers to exploit their proposer power.

Table 8 uses these probit estimates to compute the expected value (EV) an all public goods offer and the (theoretical) SSPE offer versus the offer that maximizes the proposers expected value.[24]

First, because of the dominance of the all public good offer when $\alpha = .3$, and the near 100% acceptance of all public good offers, all three cases yield essentially the same EV with $\alpha = .3$. Second, the expected benefits of making the profit maximizing offer as opposed to the all public goods offer is quite small for $\alpha = 0.45$ which is consistent with the high frequency of all public good offers here along with the small shares proposers take for themselves for equilibrium type offers. (The all public goods offer is expected to give only \$0.28 less than the offer that maximizes expected value; less than 2% more than the payoff from the all public goods offer.) On the other hand, with $\alpha = 0.55$, the all public goods offer is predicted to give \$1.37 less, or between 8% and 9% of the payoffs from the all public goods offer. This creates much stronger incentives to move away from the all public goods offer in the $\alpha = 0.55$ treatment.

The argument developed above is reinforced by simply looking at the average payoff to

[24] The expected value is computed as the probability that an offer is accepted times how much money a proposer is receiving in that offer plus the probability the offer is rejected multiplied by 0.8 times the average payoffs which is used as the approximation to the continuation value.

	Number of Subjects Offered Private Allocations:					
	0	1	2	3	4	5
$\alpha = 0.3$						
Private Share to Proposer	0.000	0.020		0.100	0.100	0.053
Public Share	1.000	0.980		0.720	0.800	0.733
Payoff to Proposer	\$24.50	\$24.31		\$19.14	\$21.10	\$18.77
$\alpha = 0.45$						
Private Share to Proposer	0.000	0.101		0.173	0.080	0.061
Public Share	1.000	0.899		0.645	0.800	0.839
Payoff to Proposer	\$19.25	\$19.58		\$16.32	\$17.20	\$17.53
$\alpha = 0.55$						
Private Share to Proposer	0.000	0.135	0.080	0.144	0.100	0.050
Public Share	1.000	0.857	0.900	0.668	0.700	0.822
Payoff to Proposer	\$15.75	\$17.22	\$16.38	\$14.48	\$13.78	\$14.32
$\alpha = 0.75$						
Private Share to Proposer	0.000			0.408	0.270	0.250
Public	1.000			0.041	0.170	0.191
Payoff to Proposer	\$8.75			\$15.64	\$11.61	\$11.04

Private Share = share of budget allocated to the proposer.

Public Share = share of budget allocated to the public good.

Table 9: Approved Allocations

different "types" of proposals. Table 9 shows the returns on accepted offers of different types. The row labeled "Private Share to Proposer" shows the share of francs allocated to the proposer, and the row labeled "Public Share" shows the share of francs allocated to the public good. The row labeled "Payoff to Proposer" gives the dollar payoffs to the proposer for the different possible allocations. Thus, for example, with $\alpha = .75$ for accepted offers involving MWCs, the proposer averages \$15.64, \$6.89 more than with an all public good proposal, and \$4.60 more than the second most popular proposal - private benefits to all 5 subjects along with some public good. For $\alpha = 0.45$ proposers average 33¢ more for equilibrium type offers compared to the more popular all public good offer. In contrast, with $\alpha = 0.55$ equilibrium type offers yield \$1.47 more, on average, for proposers than an all public good proposal.

To summarize, deviations from the theory in the mixed region can be explained by the interaction between how potential coalition partners will vote and proposers responses to these votes (and proposers' beliefs about how various proposals will be received). That is, in the mixed region the empirical continuation value (the continuation value of the game based on the discounted average payoffs in the data) provides a much better characterization of when proposals will be accepted or rejected in the mixed region than does the continuation value given by the SSPE. That is, the large shares required to secure positive votes for a proposal to pass require much higher levels of public goods provision in the mixed region than can be achieved under the SSPE allocation. And proposers by and large seem to anticipate, and respond, to these expectations of potential coalition partners.

4.3 Discussion

In the case where $\alpha = 0.75$ the results reported here are similar to results reported in previous experiments investigating the Baron-Ferejohn model. With $\alpha = .75$ the theory calls for an all private goods allocation within a minimum winning coalition (two out of five subjects get nothing), and with the proposer getting a significantly larger share than her coalition partners, which is what we observe. Further, the frequency of MWCs is very similar to results from prior experiments on multilateral bargaining with only particularistic goods. For example, FKM (2005c) report between 61% and 90% MWCs, depending on the treatment, with committees/legislatures of 3 subjects, and FKM (2005a) report between 63% and 83% MWCs, depending on the treatment, with committees/legislatures of 5 subjects.

Also, within the minimum winning coalition proposers obtain significantly more private goods than their coalition partners, which is what the theory predicts, but they obtain much less than the stationary subgame perfect equilibrium predicts. The level of proposer power observed in this region is close to what has been observed in previous legislative bargaining experiments with all particularistic goods. In this study, proposer's take in MWC is about 42% of ressources while FKL report proposer power of about 40% in MWC passed the initial 5 rounds for the closed amendment rule treatment and FKM 2005c report also proposer power of 40% for accepted MWC.[25]

Two additional results find a parallel in our earlier studies of the BF model. First, most bargaining rounds end in stage 1. That result has been observed in all of our prior experiments. Second, the fact that sometimes the proposer's share, which is typically greater than shares offered to coalition partners, negatively affects voting has also been observed in one or more treatments in each of our previous studies of the BF model (FKL, FKMa, FKLc).

Given that potential coalition partners are unwilling to accept very large differences in earnings relative to what proposer's earned, provides a strong incentive for proposers to provide larger than predicted public good allocations in the mixed region. For example, suppose that with $\alpha = .45$ proposers decided to go with all private goods within a MWC. This would give them a total of \$22.50 to allocate. Also suppose that proposers took the same absolute dollar amount more (\$4.50) than responders got on average within MWCs with $\alpha = .75$. (This is probably more than they could get away with given that there is an element of relative income differences that impacts how responders vote.) Then their take would be \$10.50, far smaller than what they would get with an all public good allocation (\$19.50) or what they got on average with an equilibrium type offer with $\alpha = .45$ (\$19.58). Similar results hold for $\alpha = .55$; proposer's share of \$12.16 with an all private good allocation within an MWC versus \$15.75 with an all public good allocation or \$17.22 earned on average for equilibrium type offers. The point here is that proposers would have to be income minimizers not to propose a substantial allocation to public goods within the mixed region, with the greater than predicted allocation a consequence of the negative effect of the on the likelihood of a proposal being accepted if they take too large a share.

Our results also have implications for the other regarding preference literature in eco-

[25] FKL involved legisislatures of 5 members with $\delta = 0.8$ whereas FKMc involved $\delta = 1$.

nomics. First, the abundance of MWC offers with $\alpha = .75$ (as well as reported in previous experiments with only particularistic goods) indicates that subjects do not have maximin preferences. That is, a taste for maximizing the benefits for the least well off (Charness and Rabin, 2002; Englemann and Strobel, 2004).[26] Second, in the region where the model predicts only private goods, subjects had the opportunity to provide a perfectly egalitarian distribution that was also a more efficient allocation (in the sense of providing more total benefits) than the minimum winning coalitions obtained, by making an all public good allocation. Nevertheless, all public good allocations only accounted for 3% of all proposals, even though such proposals were almost certain to be passed. Rather subjects opted overwhelmingly for minimum winning coalitions which provided greater benefits to the members of the coalition than they could have gotten with an all public good allocation. These results are inconsistent with recent suggestions from the other regarding preferences literature that subjects have a taste for efficiency (see, for example, Charness and Rabin, 2002). There are several obvious differences between the present experiment and these other experiments: namely the present experiment involves bargaining and these other studies involve simple dictator games in which the proposers' benefits are not impacted, or minimally impacted, by opting for a more efficient allocation, or maximizing the benefits of the least well off.

Another type of other regarding preference proposed to explain over provision of public goods in VCM experiments is the "warm glow" effect – the good feeling subjects get for helping others. Although the warm glow might be part of the reason why more than predicted public goods are provided in the mixed region, it is inconsistent with the fact that almost no public goods are provided with $\alpha = 0.75$. That treatment is really the one that comes in sharpest contrast with the warm glow explanation of public goods provision in VCM experiments because it is in many ways similar to it. In both cases the equilibrium prediction is for no public goods to be provided. And in both cases it is more efficient for all the resources to go toward the public good. However, unlike in the VCM experiments there is almost no provision of public good here with $\alpha = 0.75$. And this occurs right from the start in that there is no more public good provision than private good provision with $\alpha = .3$ where it's dominant to provide only public goods. This is not to say there are no

[26] Further, with respect to games with only particularistic goods Montero (2007) shows that the standard models of other regarding preferences (e.g., Fehr-Schmidt, 1999) predict that proposer would exhibit even more proposer power than if subjects didn't have other regarding preferences, and this is in clear contradiction with the data in this experiment and previous experiments as well.

similarities with VCM experiments as there is over provision of public goods in the mixed region, but over provision in the present case does not seem to result primarily from a warm glow effect. Finally the level of public good provision in the mixed region does not go away or decrease systematically over time as in the typical VCM experiment. The latter is most often attributed to learning and/or end game effects in a repeated play game setting. However, in the present case public good provision is an equilibrium prediction within a one-shot game with, as we have argued, overprovision resulting from "equity considerations" typically found in bilateral bargaining games in conjunction with income maximizing choice on the part of proposers.

5 Conclusions

We investigated a simple model of public goods provision within a legislative bargaining framework. In the model, legislators/committee members have preferences over public and private goods that they must decide between under a fixed budget constraint. (Taxes required to support the budget are exogenous to the model.) Our experimental treatment conditions focus on varying the weight subjects place on public versus private goods, spanning the range of predicted outcomes from all public goods, to mixed public and private goods, to exclusively private goods. We put special emphasis on the mixed region with its counterintuitive prediction that public good provision will increase as the value of the public good decreases. The model also predicts that in the mixed region, private goods will be allocated only to the proposer, the expression of proposer power within the mixed region.

The total amount of public goods provided remains flat, and in the neighborhood of 95%, going from the region where the model predicts exclusive provision of public goods to the beginning of the mixed public and private good region.[27] Within the mixed region we find (i) when private goods are provided, in the large majority of cases they go exclusively to proposers as the theory predicts, (ii) there is excess provision of public goods relative to what the theory predicts because of the high frequency of all public good allocations, and the lower then predicted levels of private goods proposers' take with equilibrium type allocations, and (iii) the level of public good provision falls as the value of the public goods

[27] All of the summary statistics provided here consist of more experienced subject behavior - periods 10 and above.

decreases, contrary to the model's predictions but best response to observed voting behavior.

Our results have several implications for the legislative bargaining literature. First, the fact that as the weight legislators place on private goods increases, the share of particularistic goods provided within the mixed region increases, supports the intuition, as well as the empirical literature, that single member districts tend to produce more pork than do legislators elected from national lists. This support for the empirical literature comes without the confounding factors associated with comparing outcomes between nation states with their different cultures, histories, and other potential confounding factors. Second, the reduction in the supply of public goods as the weight placed on private goods (α) increases within the mixed region directly contradicts the comparative static prediction of the Volden-Wiseman model under the SSPE refinement, the standard refinement for games of this sort. Rather this outcome can be rationalized by agents' voting patterns, and the actual proposals made in response to (or in anticipation of) these voting patterns, as the empirical continuation value of the game differs substantially from the value specified under the SSPE.

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A Additional Results

	Number of Subjects Offered Private Allocations					
	0	1	2	3	4	5
$\alpha = 0.3$	**0.86**	0.02	0.00	0.05	0.2	0.05
$\alpha = 0.45$	0.57	**0.24**	0.00	0.07	0.01	0.10
$\alpha = 0.55$	0.40	**0.43**	0.01	0.08	0.01	0.06
$\alpha = 0.75$	0.01	0.00	0.00	**0.66**	0.03	0.30
	Rounds 10 and Above					
$\alpha = 0.3$	**0.80**	0.07	0.00	0.07	0.00	0.07
$\alpha = 0.45$	0.62	**0.27**	0.00	0.03	0.00	0.08
$\alpha = 0.55$	0.30	**0.64**	0.00	0.03	0.00	0.03
$\alpha = 0.75$	0.06	0.00	0.00	**0.67**	0.00	0.28

Equilibrium Type Offers are in Bold.

Table 10: Frequency With Which Subjects are Allocated Private Benefits in Accepted Proposals

	All Rounds	Rounds >9
$\alpha = 0.3$	0.959	0.973
$\alpha = 0.45$	0.932	0.960
$\alpha = 0.55$	0.899	0.890
$\alpha = 0.75$	0.092	0.072

Table 11: Average Provision of Public Good for Accepted Proposals